which I have lately described (Proc. Roy. Soc., vol. lxxxix., p. 133). Moreover, the merging of two such series into one formula is open to the objection that it involves multiplication by 4 of the series constant, which would otherwise be universal. It may be possible, however, to test this point by observations of the Zeeman effects on the lines, and I shall make this experiment at the first opportunity.

I may add that experiments made by Prof. Strutt and myself are in harmony with those of Mr. Evans in showing that the lines under consideration do not occur in mixtures of hydrogen with neon or argon.

A. FOWLER.

Imperial College of Science and Technology,
South Kensington, September 13.

### The Elephant Trench at Dewlish—Was it Dug?

THE Rev. Osmond Fisher makes the interesting suggestion that the curious trough at Dewlish, in which numerous remains of *Elephas meridionalis* were found, was an artificial trench, dug as a sort of pitfall to intercept and disable wild animals driven across it. Perhaps, as having seen the excavations made by Mr. Mansel-Pleydell, I may say a word on this point.

Open trenches in the soft chalk are unknown elsewhere, though they are common enough in the hard mountain limestone. I therefore examined this trench most carefully, in order to find out how it had originated, and whether man had had anything to do with it. I am still much puzzled as to its exact mode of excavation; but certain peculiarities convinced me that it was due to natural agencies, and that it was probably cut by the swirl of the fine dust-like quartz-sand which, mixed with polished flints, now fills its lower part. I could find no implements, and could nowhere see traces of pick marks. The sides of the trench, where not damaged by the workmen who had just cleared it, were curiously smooth; but the flint-nodules projected into the cavity from either side, as though the softer chalk had been scoured away. The abrupt rounded end of the trench was most peculiar, and as I cleaned this out myself, dusting away the sand from the smoothed face of the chalk, I am sure that there were here neither tool-marks nor rubbings such as might be made by a man working in the trench, or by wild beasts. In short, the smooth, rounded contours suggested the eddying of wind, and the absence of any crack or joint showed that here at any rate the rounding was not likely to be due to percolating water.

Beneath the elephant bones, which occurred in a layer a few feet down, the infilling of the trench seems to be a fine dust-like, unfossiliferous sand, which was not bottomed, as Mr. Mansel-Pleydell's excavations were made primarily to obtain elephant remains, and these were in such a soft condition as to make removal almost impossible. If this sand-filled fissure is found to continue downward, but is too narrow for a man to work in, it will show that the trench is not artificial. I could only just squeeze past in one or two places; but the upper part of the trench was passable; I think, however, that it tended to narrow downward, but at the time of my visit the bones had not been removed, and I could not excavate below them.

Perhaps someone acquainted with plateaus of soft limestone under desert conditions can say whether there is any tendency for the wind to cut trenches with rounded blind ends, such as the Dewlish trench has. In this connection, it is worth noting that our newer Pliocene land-faunas show distinct indications of drier and more sunny conditions than we have at present. A gazelle, an antelope, and several land and fresh-water mollusca point in that direction. Under dry conditions, and before the loose flints were swept away during the glacial period, our chalk-downs would probably be stony deserts, quite unlike the green hills we now see.

CLEMENT REID.

Milford-on-Sea.

### Red-water Phenomenon due to Euglena.

THE red-water phenomenon due to a Euglena described by Prof. Dendy in NATURE of August 7 has been observed by me in Pretoria. In this case, however, the Euglena swims freely about in the water, and also forms a red gelatinous scum on the surface of the damp mud on the side of the pond. In swimming they seldom show euglenoid movement. A flagellum longer than the body can be easily seen under the microscope at the anterior end of the body, but it always trails along the body with lashing movements. If they become stranded on the mud at the edge of the pond, they soon become spherical and encysted in a mucilaginous covering much wider than the body and showing a layered formation. I have not observed any bubbles of gas given off, although I have kept large quantities of them under observation for long periods. They appear to prefer the encysted form, as they always swim to the edge of the vessel towards the light and form a deep red line along the edge, which gradually becomes dry. If more water is added and the vessel turned round, they will leave their cysts and again swim towards the light side. They are of a fairly large size, and have a cylindrical body tapering to a sharp point at the posterior end, where the last portion is free from pigment Chlorophyll is present, and is easily seen amongst the red in those that have just come out of the encysted stage, but later on it entirely disappears.

HORACE A. WAGER.

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August 30.

### Distance of the Visible Horizon.

MR. W. MOSS'S account in NATURE for August 7, p. 583, as to how to get the area of a sphere theoretically visible at any altitude is interesting; but can he, or any of your readers, say what the formula is for obtaining the distance actually visible with an average amount of refraction? So far as I can discover, all ordinary books of tables ignore this, although such a table would be very useful.

A table is given in Chamber's Mathematical Tables, p. 436, for the distance of the visible horizon, but the explanation, p. xl., states that this is theoretical, and that a correction for refraction should be made, although nowhere is any table or formula given for such correction.

T. W. BACKHOUSE.

West Hendon House, Sunderland
September 6, 1913.

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ATMOSPHERIC refraction is such a varying quantity that no rule respecting it can be laid down applicable in all circumstances; as in cases of mirage, for instance, where vessels below the horizon are seen standing above it, and turned upside down. The refraction of the sea horizon is the great difficulty in obtaining correctly the position of vessels at sea. This can be eliminated in most cases by taking observations of the heavenly bodies to opposite sides of the horizon; for latitude in a north as well as in a south direction; for longitude in an east as well as in a west direction. When only one heavenly object is available this is not always practicable, but it can be done when the altitude is 60° or upwards.

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In the appendix to Captain Parry's "Arctic Voyage, 1821–3," p. 187, some observations of the sea horizon by Mr. Fisher are given. He found a variation of 18° in the Arctic region, the ice horizon being elevated in summer and depressed in winter. The variation of the place of the apparent horizon, as a question of unequal temperature, was discussed generally by M. Biot in 1809. But no detailed observations on the subject have, so far as I am aware, been yet made.

The correction for refraction in obtaining the heights of mountains by angles of depression to the waterline of points or lighthouses, or by angles of elevation from points the height of which has been ascertained, is taken empirically, in nautical surveying, as $\frac{1}{12}$th the distance of the object observed. The results thus obtained are fairly accurate. For instance, when surveying the Gulf of Suez in 1871, the observations from the summit of Jebel Hooswah gave the results shown in the accompanying table.

T. H. Tizard.

| Place of observation | Object observed | Angle of elevation | Angle of depression | Refraction + or − $\frac{1}{12}$ dist. | Corrected angle | Dist. | Diff. of level | Height of | | Dip. | Corrected height | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Object observed | Theod. | | Place of observer | Object observed |
| | | | ° ′ ″ | ′ ″ | ° ′ ″ | ′ | | | | | | |
| Summit of Jebel Hooswah | Water line of Tur point... | — | 1 27 30 | +1 21 | 1 28 51 | 16·38 | 2573 | 0 | 5 ft. | 237 | 2331 | 0 |
| | ,, at Tur ... ... | — | 1 20 0 | +1 31 | 1 21 31 | 18·24 | 2633 | 0 | ,, | 292 | 2336 | 0 |
| | ,, Marabut point | — | 3 57 0 | +0 27 | 3 57 27 | 5·48 | 2303 | 0 | ,, | 26 | 2272 | 0 |
| | ,, point this side of Marabut ... ... ... | — | 4 1 0 | +0 26 | 4 1 26 | 5·35 | 2287 | 0 | ,, | 24 | 2258 | 0 |
| | Water line to the right ... | — | 4 49 0 | +0 23 | 4 49 23 | 4·60 | 2358 | 0 | ,, | 19 | 2334 | 0 |
| | ,, of station point | — | 16 12 0 | +0 6 | 16 12 6 | 1·30 | 2295 | 0 | ,, | 1 | 2289 | 0 |
| | ,, of another point with station ... | — | 11 18 0 | +0 9 | 11 18 9 | 1·85 | 2246 | 0 | ,, | 3 | 2238 | 0 |
| | Water line of another point | — | 8 54 40 | +0 12 | 8 54 52 | 2·40 | 2287 | 0 | ,, | 5 | 2277 | 0 |
| | ,, by Asses ears.. | — | 6 14 0 | +0 17 | 6 14 17 | 3·48 | 2311 | 0 | ,, | 11 | 2295 | 0 |
| Mean height 2292 ft. Max. height observations 2336. Minimum 2238. Range 98 ft. | | | | | | | | | | | | |
| For greater distances and heights the angles from and to Jebel Serbal may be given as follows:— | | | | | | | | | | | | |
| Summit of Jebel Serbal | Water line of Gharib lighthouse ... ... ... ... | — | 2 6 0 | +2 47 | 2 8 47 | 33·48 | 7623 | 0 | ,, | 989 | 6629 | 0 |
| | Water line of Zaffarana lighthouse ... ... ... | — | 1 28 0 | +4 53 | 1 32 53 | 58·55 | 9613 | 0 | ,, | 3025 | 6583 | 0 |
| | Point to south-east of Zaffarana lighthouse .. | — | 2 25 0 | +2 24 | 2 27 24 | 28·9 | 7533 | 0 | ,, | 737 | 6791 | 0 |
| | Abu Zenina point ... ... | — | 1 58 0 | +3 07 | 2 1 7 | 37·33 | 7994 | 0 | ,, | 1230 | 6758 | 0 |
| | Water line Tur Spit ... | — | 2 42 0 | +2 4 | 2 44 4 | 24·90 | 7225 | 0 | ,, | 551 | 6669 | 0 |
| | Summit of Jebel Hooswah | — | 2 30 0 | +1 29 | 2 31 29 | 17·92 | 4801 | 2292 | ,, | 285 | 6803 | 2292 |
| Mean height 6706 ft. Max. 6803. Min. 6583. Extreme range 220 ft. | | | | | | | | | | | | |

## The Undagraph.

Last week the Dominion Astronomical Observatory installed at Chebucto, near Halifax, Nova Scotia, a wave-counter, which I have called an "undagraph." The site, a granite cliff 110 ft. high, on which is a lighthouse, faces the broad waters of the Atlantic. The coast hereabouts is bold and rocky.

Modern seismographs record tremors of the earth—microseisms—not attributable to earthquakes, and investigators have traced them to the action of the sea during storms. These microseisms manifest themselves particularly markedly in Ottawa and in Europe from autumn to spring, *i.e.* during the winter or stormy season. Their period ranges, say, from four to seven seconds, and the greater the storm or steeper the gradient of the "low" on the water along the coast, the greater is the amplitude of the microseisms.

In order to correlate the period of the waves of the ocean which pound upon the coast with the period of the microsiesms, the above instrument has been installed. It may be mentioned that a trial instrument was made for the International Seismological Association by the Cambridge Instrument Company, and installed on the pier at Newcastle-on-Tyne. It did its work, but the position is not suitable for the purposes of correlation. The west coast of Ireland or of Norway would have been better. However, practical difficulties stood in the way for utilising either for the trial instrument. The present instrument, made by the same company, has been improved on the former, but has as yet no contrivance for registering the height or magnitude of the waves, which is so very desirable.

The principle of the instrument is very simple. It is based on Boyle's law, $PV = \text{constant}$. An iron pipe —in our case 625 ft. long—is led from the instrument, the diaphragm part, to and into the ocean to a depth beneath the trough of the assumed highest waves at low tide, say 15 ft. The sea-end of the pipe is open. The wave passing over it causes the water to rise in the pipe and compress the air beyond, whereby the leather diaphragm is raised, and electric contact is made. By means of the armature of an electromagnet a toothed wheel is pushed forward, one tooth for every wave, and with one revolution, or 120 waves, the recording pen returns to its zero. The record presents a series of finely serrated oblique lines, each representing 120 waves. Clockwork with pen traces at the edge of the paper a time scale, making a break every hour, the linear measure of which is 6 cm. A fresh roll of paper is put on once a week. A small leak is provided in the diaphragm chamber, to cut out the effect of the slowly rising and ebbing tide, which, however, does not affect the rapid action by the waves.

The sea-end of the pipe gives the most anxiety, as it has to resist the immense force of the waves during storms. The greater part of the 625 ft. is of half-inch galvanised iron pipe, while the ocean end, about 100 ft., is of four-inch pipe, with reducing pipes between the preceding two. The bedding of the submerged part will be in about four tons of concrete

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